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Title of Paper

A quality centric assessment of Japanese Operations Management solutions for Indian Manufacturing Industry on Business Performance

Abstract

A nation's management system is not just a set of tools and techniques that can be applied without regard to the socio-cultural context. The effectiveness of any management solution can be understood only within the cultural , socio-political and economic framework of the people who are doing the managing and being managed During the last two decades, TQM and TPM have been implemented in Indian manufacturing industry to take on the challenge of transition from protected economy to global competition. Earlier the strategic implications of improvement solutions had not been understood. The executives have now started realizing.

Though their contribution in improving business performance in Indian scenario has been cited by some authors but an urgent need for empirical study to establish evidences of effectiveness of two drives on business performance has also been expressed by experts.

Similarly, a comparative assessment of impact of both drives in Indian context is also considered important by researchers and practitioners. A research study addressing the preparedness/status of manufacturing industry for these Japanese Quality and Maintenance centric solutions is also important in global context. Today ,India the fourth largest economy of the world ,is seen as an important sourcing base similar to China, for the world as a whole. There is paucity of research studies addressing the behaviour of Japanese solutions in Indian context.

These two improvement solutions are being practiced for raising performance standards of Indian companies to world class level. Both are considered complementary to each other and thereby being implemented simultaneously by many companies to achieve synergy. This paper aims to provide empirical evidences on comparative contributions of two solutions in improving business performance in context to Indian manufacturing industry. It also tries to establish a synergetic effect of TQM and TPM, when implemented in tandem, which has never been investigated before. The study is based on data collected through a survey questionnaire as research instrument and statistical analysis .

Key words:

TQM, TPM, Profitability, Performance, Manufacturing industry, India

Table I: TQM, TPM and parameters of business performance

Parameters of Business Performance	TQM	TPM
A. Parameters of Profitability		
Increase in Profitability	Broh (1982), Soin (1993), Ross (1995), Logothetis (1997), Mohanty & Lakhe (2000)	Maggard & Rhyne (1992), Steinbatcher et. al. (1992), Patterson et. al. (1996), Yamashima (2000)
B. Parameters of Operating Performance		
Increase in Productivity [P]	Adam (1981), Logothetis (1997), Zink (1998), Lee (2000), Mohanty & lakhe (2000)	Nakajima (1988), Takahashi & Osada (1989), Steinbatcher et. al. (1992), Patterson et. al. (1996)
Reduction in Costs [C]	Juran & Gryna (1980), Zink (1995), Logothetis (1997), Lee (2000)	Nakajima (1988), Takahashi & Osada (1989), Steinbatcher et. al. (1992), Patterson et. al. (1996)
Improvement in Quality [Q]	Juran & Gryna (1980), Broh Robert A. (1982), Sheigo Shingo (1986), Feigenbaum (1991), Zink (1995), Logothetis (1997)	Nakajima (1988), Takahashi & Osada (1989), Steinbatcher (1992), Yamashima (2000)
Improvement in Delivery [D]	Broh (1982), Zink (1995), Logothetis (1997), Lee (2000)	Nakajima (1988), Takahashi & Osada (1989), Steinbatcher (1992), Patterson (1996)
Improvement in Safety [S]	Garvin (1988), Feigenbaum (1994)	Nakajima (1988), Takahashi & Osada (1989), Steinbatcher (1992)
Improvement in Morale [M]	Broh (1982), Ahire et. al. (1995), Logothetis (1997), Garvin (1991)	Nakajima (1988), Takahashi & Osada (1989), Steinbatcher (1992),, Yamashima (2000)

Table II: Distribution of responding companies according to sector of industry, approach adopted and geographical area.

Sector of Industry		Improvement Approach		Geographical Area	
Automobile	[30%]	TQM alone	[51%]	East	[3%]
Engineering	[38%]	TPM alone	[23%]	North	[26%]
Process	[32%]	Combined	[26%]	South	[20%]
--	--	--	--	West	[51%]

Table III: Mean and standard deviation of improvement in parameters of profitability

Improvement Approach	Mean value	Std. deviation.	Mean value	Std. deviation	Mean value	Std. deviation
TQM	Phase A	n =21	Phase B	n=32	Phase C	n=20
F1 (Market share)	1.54	0.68	2.56	0.98	3.05	0.89
F2 (ROI)	1.77	0.78	2.52	0.70	3.12	0.88
F3 (Profit Margin)	1.69	0.75	2.58	0.87	3.28	0.82
TPM	Phase A	n = 13	Phase B	n =18	Phase C	n=1
F1 (Market share)	1.83	0.75	2.16	0.99	-	-
F2 (ROI)	2.00	0.63	2.58	0.73	-	-
F3 (Profit Margin)	2.00	0.63	2.66	0.79	-	-
Combined	Phase A	n=1	Phase B	n=19	Phase C	n=18
F1 (Market share)	-	-	3.18	0.60	3.50	0.77
F2 (ROI)	-	-	3.27	0.64	3.25	0.86
F3 (Profit Margin)	-	-	3.27	0.64	3.50	0.89

Table IV: Statistical tools used for Comparative study of improvement in profitability

Phase	Comparative study done on	Statistical Tools used
Phase A (less than 3 years of experience)	TQM and TPM	Two tailed t test with 5% level of significance
Phase B (3 to 5 years of experience)	TQM, TPM and Combined	Single factor ANOVA Two tailed t test with 5% level of significance
Phase C (more than 5 years of experience)	TQM and Combined	Two tailed t test with 5% level of significance

Table V: Results of two tailed t tests for parameters of profitability in transition phase

Parameters	TQM mean (n = 21)	TPM mean (n=13)	t values	t crit p= 0.05
F1[market share]	1.54	1.83	0.456	2.074
F2 [ROI]	1.77	2.00	0.495	2.074
F3 [net profit]	1.69	2.00	0.372	2.074

Table VI: Results of single factor ANOVA for parameters of profitability in stability phase

Parameters	TQM mean (n=32)	TPM mean (n=18)	Combined mean (n=19)	F value	P value	F critical. at 5%
F1[market share]	2.56	2.16	3.18	3.83	0.030	3.25
F2 [ROI]	2.52	2.58	3.27	4.44	0.018	3.25
F3 [net profit]	2.58	2.66	3.27	3.76	0.045	3.25

Table VII: Results of individual t tests for the three approaches in stability phase

Parameters	Combined and TQM		Combined and TPM		TQM and TPM	
	t value	p value	t value	p value	t value	p value
F1[market share]	1.30	0.031	1.51	0.025	0.516	0.523
F2 [ROI]	0.97	0.011	1.91	0.015	0.413	0.672
F3 [net profit]	1.82	0.041	1.31	0.032	0.217	0.821

Table VIII: Results of two tailed t tests for parameters of profitability in maturity phase

Parameters	TQM mean (n = 20)	Combined approach mean (n= 18)	t values	t crit p= 0.05	p value
F1[market share]	3.05	3.50	- 1.30	2.150	0.21
F2 [ROI]	3.12	3.25	- 0.40	2.150	0.71
F3 [net profit]	3.28	3.50	- 0.70	2.150	0.48

Table IX: Mean and Standard Deviation for parameters of operating performance.

Approach	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
TQM	Phase A	n=21	Phase B	n=32	Phase C	N=20
Productivity (P)	2.33	0.73	3.09	0.71	3.43	0.75
Quality (Q)	2.77	0.55	3.76	0.89	4.1	0.74
Cost (C)	2.45	0.64	2.92	0.74	3.01	0.75
Delivery (D)	2.55	0.7	3.27	0.84	3.61	0.90
Safety&Hygiene (S)	2.63	0.99	3.65	0.94	3.57	0.33
Morale (M)	3.30	0.52	4.02	0.60	4.02	0.78
TPM	Phase A	n=13	Phase B	n=18	Phase C	n=1
Productivity (P)	2.55	0.76	3.52	0.80	-	-
Quality (Q)	2.74	0.70	3.61	0.77	-	-
Cost (C)	2.31	0.74	3.08	0.61	-	-
Delivery (D)	2.37	0.91	3.47	0.80	-	-
Safety&Hygiene (S)	3.05	0.95	4.08	0.81	-	-
Morale (M)	3.33	0.43	4.08	0.61	-	-
Combined	Phase A	N=1	Phase B	n=19	Phase C	n=18
Productivity (P)	-	-	3.64	0.61	3.76	0.46
Quality (Q)	-	-	4.14	0.55	4.17	0.55
Cost (C)	-	-	3.00	0.33	3.38	0.56
Delivery (D)	-	-	3.64	0.54	3.82	0.55
Safety&Hygiene (S)	-	-	3.82	0.79	4.07	0.65
Morale (M)	-	-	4.17	0.86	3.96	0.86

Table X: Results of two tailed t tests for parameters of operating performance in transition phase

Parameters of operating performance	TPM Mean (n= 13)	TQM Mean (n=21)	t value t .05 = 2.074	p value
Productivity (P)	2.56	2.33	0.73	0.47
Quality (Q)	2.74	2.78	- 0.10	0.44
Cost (C)	2.31	2.46	- 0.50	0.63
Delivery (D)	2.37	2.56	- 0.51	0.60
Safety & Hygiene (S)	3.06	2.63	0.87	0.39
Morale (M)	3.33	3.30	0.16	0.87

Table XI: Results of single factor ANOVA for parameters of operating performance in stability phase

Parameters of operating performance	TPM mean (n=18)	TQM mean (n=32)	Combined mean (n=19)	F value	p value	F critical. at p =0.05
P	3.52	3.09	3.69	3.29	0.045	3.19
Q	3.61	3.76	4.24	4.65	0.030	3.19
C	2.98	2.82	3.40	6.52	0.028	3.19
D	3.47	3.27	3.64	6.04	0.029	3.19
S	4.08	3.65	3.82	0.954	0.392	3.19
M	4.08	4.02	4.17	0.193	0.824	3.19

Table XII: Results of two tailed t tests for parameters of operating performance in maturity phase

Parameters of operating performance	TQM Mean (n =20)	Combined Approach Mean (n=18)	t value (t 0.05=2.074)	p value
P	3.41	3.76	- 2.40	0.04
Q	4.10	4.17	- 3.00	0.04
C	3.01	3.38	- 2.50	0.03
D	3.61	3.82	- 2.71	0.04
S	3.57	4.07	- 1.40	0.17
M	4.02	3.96	0.22	0.83

Introduction

The Indian manufacturing industry is witnessing a phase of transition from *license- permit regime (era of protected status, ,Swadeshi or Country made, Controls ,licenses and Quotas)* to tough global competition. Manufacturing plays an important role in the economy of every nation and India is not an exception. Today, manufacturing accounts for about 17% of the GDP and 12% of employment. There has been a growth of around 15 per cent in this sector in the year 2007. Product and process innovations, technological developments, improved managerial skills, and the availability of low cost workforce are the potential competitive capabilities of India's manufacturing. There are, however, several other aspects, which the country needs to address in order to improve its competitiveness in the global manufacturing scenario. Industries all over the world have been focusing on the technological and managerial dimensions of their operations to improve their performance and competitiveness

.The globalization and free entry of seasoned players are constantly pressurizing Indian companies to improve competitiveness by upgrading productivity and quality of their goods and services. An urgent need to make improvements in this direction has been sensed in last few years (Chandra & Shastri, 1998). A sizeable section of industry has already started preparing to achieve world class performance through various business solutions, but the most widely accepted amongst those are TQM and TPM (Sahay, Saxena and Kumar, 2000). Within the last two decades, Total Quality Management (TQM)has evolved as a strategic approach in most of the manufacturing and service organizations to respond to the challenges posed by the competitive business world .This evolution is very widespread across the globe (Lakhe and Mohanty,1994).The same is true for improvement

solutions like Total Productive Maintenance (TPM) .Like Quality ,Maintenance as entity also began as shop floor issue and became an important board room discussion matter.

TQM is defined as 'An approach to improving effectiveness and flexibility of business as a whole. It is a way of organizing and involving the whole organization, every …' (Oakland, 1988). Similarly TPM, as defined by Nakajima (1988), is 'a plant improvement methodology, which enables continuous and rapid improvement of manufacturing processes through use of employee involvement…' It calls for total effectiveness (economic efficiency or profitability) of companies. Today, both TQM and TPM have become comprehensive management strategies, which are built on common foundation of continuous improvement and organization wide involvement, but with different core focus area i.e. quality and maintenance respectively

Since its inception, Indian manufacturing industry has been influenced by western management practices. The reason lies in Indian history. India being an important British colony and consequently Indian industry typically has been exposed for decades to the onslaughts of conventional American and British management and improvement solutions. The whole matter of modernization of Indian business has been tied up with studying and practicing American and western methods. The management schools set up in India have a strong American and western orientation. Partially, this has been because of the exposure of captains of industry and academics to western management and business world.

Therefore , the strategic implications of quality and maintenance had not been understood by the industry until the middle of last decade. The executives have now started realizing

this through lessons of TQM and TPM philosophies disseminated by experts and institutions from within the country and from both east and the west. The advocates of both TQM and TPM claim the effectiveness of their respective drives in improving business performance (Yamashima, 2000; Hendricks & Singhal, 2001).

Though the contribution of TQM and TPM in improving business performance in Indian scenario has been cited by some authors (Chandra & Krishna, 1998; Nandi S.N., 1998), but a need for empirical study to establish evidences of effectiveness of two drives on business performance has also been expressed by experts (Mohanti & Lakhe, 2000).

Similarly, a comparative assessment of impact of both improvement drives in Indian context is also considered equally important by researchers and practitioners. A research study addressing the preparedness/status of manufacturing industry for these Japanese Quality and Maintenance centric solutions is also important in global context. Today ,India the fourth largest economy of the world ,is seen as an important sourcing base similar to China, for the world as a whole. There is paucity of research studies addressing the behaviour of Japanese Quality and Maintenance solutions in Indian manufacturing context.

As the absorption and adsorption of Japanese manufacturing centric quality and maintenance solutions have not been studied in details in Indian context. The culture of the organization concerned and that of the country, however, have a strong bearing on the extent to which these Japanese techniques and management practices (JTPs) make their impact as desired. Ford and Honeycutt in a comprehensive article, have discussed the relevance of the culture of a country in understanding the country's business practices. They have also established that corporate culture is company-specific and, therefore, generalization of any company-specific observations can be misleading. It is, perhaps, for

this reason that researchers have been addressing issues like adoption, implementation, and effectiveness of various Japanese techniques and management practices in the manufacturing sector of different countries.

After all a nation's management system is not just a set of tools and techniques that can be applied without regard to the socio-cultural context. The effectiveness of any management solution can be understood only within the cultural , socio-political and economic framework of the people who are doing the managing and being managed .Understandably, the success or the failure of Japanese solutions elsewhere, would depend to a large extent not only on the inherent characteristics of these solutions themselves, but largely on the extent to which these " Improvement medicines" can be adapted to the peculiar conditions of alien environments. As a corollary to this, success would also be dependent on the ability and willingness of the executives ,workers and other stakeholders to adapt those solutions in a manner that will fit their own socio-cultural milieu.

Complementary nature of TQM and TPM and their simultaneous application in Indian companies have engendered an urge to study both the improvement drives together. As TQM and TPM are not always implemented in isolation and many Indian companies have used both drives together to achieve synergy, it is also important to study a synergetic effect of both drives. In this context, three possible modes of implementation are studied i.e. TQM alone, TPM alone and Combined approach (TQM and TPM together). These three modes are termed as 'approaches' in this paper. This paper aims to make a comparative assessment of the effectiveness of TQM and TPM on business performance and to establish their synergetic effect, considering two key aspects of profitability and operating performance.

Contribution of TQM and TPM on business performance: literature review

There is abundant literature on relationship between TQM and TPM practices and business performance from different perspectives in various sectors. These initiatives have also resulted in improving competitive positions of nations and economic zones (Powell, 1995). Various researches have focused on linkage between TQM, TPM and business performance (Steinbatcher et. al., 1993; Reed et. al., 1996). Though there can be many facets of business performance, the two important aspects i.e. profitability and operating performance are considered in this research paper as already mentioned.

Literature on Improvement in profitability

A large number of studies have been carried out on relationship between TQM and profitability (Broh, 1982; Winser and Eakins, 1994; Ross, 1995; Dale and Plunket, 1995; Samson et. al., 1999; Sun, 2000). Broh (1982), concluded that quality is key to improved bottom-line (profitability) and a proper quality system can contribute in generating enormous profit for the company as well this has direct bearing on other operational performance parameters like cost, delivery, safety, and employee morale. Strategic planning Institute of Cambridge, M.A. studied relationship between quality, profitability and market share (Ross, 1995). The study revealed that quality drives market share and increased market share with superior quality leads to guaranteed profitability. Mohanty and Lakhe (2000), identified increased market and profitability as the major tangible benefits along with reduction in cost, quality and productivity improvement and reduced employee grievances. Soin (1993) provided a model to explain the linkage between quality, profitability and market share. According to him, TQM improves the business performance both internally and externally. Internally, improvement in quality results in

higher productivity, which enables the organization to lower prices, if it wishes to compete on prices. Externally higher quality improves customer satisfaction, increases customer loyalty and this results in increased market share and higher profits. A study done on profit impact on marketing strategy, emphasized the positive impact of quality on market share, profits and return on investment (Soin, 1993). Kano (1993) also established the effectiveness of TQM in improving profitability by comparing performance of Deming prize winning companies with other companies.

TPM also aims at continuous and long-term improvement in performance and therefore it results in improving financial performance of organizations in terms of market share, ROI and profits. According to Steinbatcher et. al. (1993), the benefits of various components of TPM makes this comprehensive strategy extremely powerful management tool to reduce life cycle costs of equipment and facilities and such reductions can provide greatest return on investment. In addition, it can also boost sales or market share. Nakajima (1988), the father of TPM considered it as "profitable TPM" as decreasing cost of maintenance provides an automatic improvement in bottom line profits. Maggard and Rhyne (1992) established the profitability aspects of TPM through real life cases. In his findings, Yamashima (2000) concluded that TPM could be a major source of profitability of manufacturing organizations. He argued that it is possible through effective management of equipment, machines and support services.

Literature on Improvement in operating performance

The effectiveness of TQM and TPM in improving the operating performance parameters in organizations is also professed by many experts. . Feigenbaum (1991) clearly indicated that a Total Quality Control program resulted in improved product quality, improved

production flow, improved employee morale, improved product service and delivery and reduction in operating costs and losses, field service costs etc. Logothetis (1997) explained the relationship between TQM and operating performance of the organizations. According to him TQM resulted in the improvement in quality of the product, productivity and value addition; reduction in manpower, cost of production, delivery and delivery cycle time; improvement in employee morale safety due to reliable processes and resources.

TPM has also been very successful in terms of improving operating performance of companies. TPM claims to have positive impact on Productivity (P), Quality (Q), Delivery (D), Safety & Environment (S) and Employee Morale (M) (Nakajima, 1988). This is termed by Nakajima as PQCDSM. According to him, increased automation has made the equipment as the major determinant of all process output parameters like cost, quality, delivery etc. As TPM works on the dual objectives of Zero breakdown and Zero defects, the result is improved productivity, improved quality, reduced inventory, reduced delivery cycle time, and improved safety and employee morale. Table I exhibits the relationship of TQM and TPM with parameters of performance, along with the literature supporting it.

Take in Table I

The Research Framework

The performance parameters in relation to TQM and TPM have been identified from literature review. The parameters of profitability considered for study are market share (F1), return on investment (F2) and profit margin (F3). The parameters of operating

performance are productivity (P), quality (Q), cost (C), delivery (D), safety & hygiene (S) and employee morale (M). The details of elements for each parameters of performance as taken from research instrument are shown in Appendix A.

As both TQM and TPM are continuous improvement drives and evolutionary in nature, their effectiveness may change with time and experience. Therefore, in order to assess both short term and long term effectiveness, three time periods or phases have been identified. These are:

1. **Period of Transition** (upto 3 years of implementation)

This is a period during which initial investment and efforts are made to overcome initial resistance and to orient organization as per requirements of the approaches. Similarly, the situation may require to develop new performance indicators and various data capturing, measuring and analyzing tools and concepts. In this phase, the organization experiences changes in work culture, work practices, policies etc. The period of transition normally goes for three years since beginning of implementation. The period of transition is coded as Phase A for the purpose of analysis.

2. **Period of Stability** (3 to 5 years of implementation)

This is the period during which the improvement drive gets stabilized and organization starts realizing benefits of TQM and TPM. Period of stability is coded as Phase B for study purpose.

3. **Period of Maturity** (more than 5 years of implementation)

The continuous improvement approaches of TQM and TPM are never ending and can continue for ever. Over a long period the benefits accrued by these improvement drives give strategic and competitive edge in terms of cost, delivery, flexibility and customer

satisfaction in comparison to competitors. This phase represents long term experiences with these two improvement drives in terms of strategic leverage over other companies. Period of maturity is coded as Phase C for the purpose of analysis.

Though, both TQM and TPM are comprehensive improvement drives, but there are cases where these are implemented simultaneously to obtain synergetic effect. Therefore, as previously mentioned, the study considers three approaches, which are TQM alone, TPM alone and Combined approach (TQM and TPM together). The purpose is to make a comparative assessment of effectiveness of two drives as well as to assess their synergetic effect.

Research Objectives and Hypotheses

This paper aims to establish the effectiveness of TQM and TPM in Indian manufacturing industry. It focuses on following specific aspects.

1. A comparative assessment of effectiveness of TQM and TPM in improving business performance of Indian manufacturing companies over three time periods or phases.
2. Establishment of synergetic effects of TQM and TPM, when these are implemented in tandem.

The effectiveness is measured on three parameters of profitability and six parameters of operating performance as described in literature review. Following hypotheses have been formulated for the study.

I. Hypotheses related to improvement in profitability

a. It is proposed that both TQM and TPM are equally effective in improving profitability of the organizations. The formulated hypothesis is

H 1a*: The contributions of TQM and TPM in improving profitability of organizations in terms of market share (F1), ROI (F2) and profit margin(F3) are similar in magnitude .*

b. The effect of Combined approach on profitability is proposed to be more than TQM and TPM alone. Following hypothesis is formulated to test this proposition

H1b: ***T****he contribution of combined approach in improving profitability is more than both TQM and TPM alone.*

II. Hypotheses related to improvement in operating performance

a. It is proposed that TQM and TPM are equally effective in improving parameters of operating performance. Following hypothesis is formulated to test this proposition.

H2a: *The contribution of TQM and TPM in improving parameters of operating performance (i.e. P, Q, C, D, S, M) is similar in magnitude.*

b. The Combined approach is proposed to have higher contribution in improving parameters of operating performance. Following hypothesis is formulated to test this proposition.

H2b: *The contribution of combined approach in improving parameters of operating performance is more than TQM and TPM alone*

The parameters of profitability and operating performance measured on 5 points scale. The points 1 to 5 in the scale indicate

1- no improvement at all; 2- improvement less than 5%; 3- improvement of 5 to 20%; 4 – improvement of 21% to 100% and 5- improvement of more than 100%.

Sampling Design and Response Profile

The research is based on empirical data collected through a questionnaire from Indian companies which have implemented TQM and TPM. The three major sectors of manufacturing industry i.e. automobile, engineering and process have been considered in the domain of study with companies from both public and private sectors. A list of 460 companies was prepared with the help of information collected from leading industry chambers like Confederation of Indian industry (CII), Federation of Indian Chambers of Commerce and Industry (FICCI) and Indian Merchant Chambers (IMC) and TQM and TPM councils.

A survey questionnaire was sent to all 460 companies through mail. As many as 45 company headquarters and plants were visited personally to verify the data collected. The efforts resulted in getting responses from 143 companies. Out of these 73 have implemented TQM, 32 have implemented TPM and 38 have implemented both TQM and TPM. Table II shows the distribution of sample on the basis of type of industry, approach adopted, scale of operation and the geographical area. There are 42 companies from automobile sector, 55 from engineering sector and 46 from process sector. The number of companies in TPM category is relatively low compared to other two approaches because of smaller population as compared to TQM. The reason may be that TPM is relatively newer approach in India and the organizations currently adopting it in isolation are fewer in

number. In terms of geographical area there are 72 organizations from the west and there is hardly any representation from the east. This is for the reason that industrial growth has been higher in western India as compared to other regions. The situation is similar to China, where industry concentration is more prominent in eastern region, with states like Shanghai.

Take in Table II

Analysis of Data and tests of Hypotheses

A comparative assessment of contribution of TQM, TPM and Combined approach is explained in this section along with testing of hypotheses for both profitability and operating performance.

Improvement in Profitability through TQM and TPM

The improvement contributed by each approach is determined by calculating means and standard deviations for each period of transition [Phases A, B and C] separately. The values of mean and standard deviations are calculated by use of Microsoft EXCEL-2000. The values are shown in table III.

Take in Table III

The mean values alongwith standard deviations for each phase indicate the level of improvement contributed by each approach in that particular phase. This is based on the data collected through questionnaire.

In order to make a comparative assessment of improvement in profitability parameters, two tailed t tests and single factor ANOVA technique are used depending on the availability of data for each phase. As indicated in table III, there is only one observation each for Combined approach in category

A and TPM in category C. The use of t test and single factor ANOVA as carried out in this research work is explained in table IV.

Take in Table IV

Profitability Improvement in Transition Phase

The data in table 3 indicate that for category A organizations, the mean values for F1, F2 and F3 are between 1 and 2. This implies that the contribution of both TQM and TPM in improving profitability has been marginally low. This may probably be because of initial investments made on implementation and period of less than 3 years is too small to reap benefits from these approaches. In addition, orienting employees with heterogeneity and cultural diversity towards these approaches in Indian context also requires considerable efforts. The mean values for TPM have been higher than TQM in all the three parameters. The results are shown in table V.

Take in Table V

The results indicate that the difference on F1, F2 and F3 is not significant at 5% level of confidence (p=0.05). The t values obtained for F1, F2 and F3 are 0.456, 0.495 and 0.372, whereas critical t value at p=0.05 for two tailed test is 2.074. This proves hypothesis H1a

and the proposition that the contribution of TQM and TPM in improvement of parameters F1, F2 and F3 is same in transition phase.

Profitability Improvement in Stability Phase

The values of mean and standard deviation as given in table III for parameters F1, F2 and F3 under TQM and TPM for stability phase are between 2.5 and3. This indicates that both TQM and TPM have been able to achieve improvement in all the parameters of profitability in a span of 3 to 5 years. The corresponding figures for organizations, which have adopted combined approach are more than 3 for all the three parameters. In order to understand the significance of difference in the improvement contributed by the three approaches, single factor ANOVA tests have been carried out. The results of ANOVA tests are shown in table VI. The actual F values are more than the critical F values (p=0.05) for F1,F2 and F3 , therefore, it can be concluded that the difference in mean values between three samples [TQM, TPM and Combined] is significant for improvement in market share, improvement in ROI and improvement in profit margin.

Take in Table VI

The corresponding p values for F1, F2 and F3 are 0.030, 0.018 and 0.045 respectively. In order to determine the significance of difference between mean values of individual approaches, two tailed t tests were again carried out between each pairs i.e. Combined and TQM, Combined and TPM and TQM and TPM. These tests indicated that contribution of combined approach in improving parameters of profitability is significantly higher than TQM and TPM, when implemented in isolation. The results of t tests are shown in table VII. This proves the hypotheses H1b that contribution of Combined approach in

improving parameters of profitability is more than that of TQM and TPM alone. Further, the effect of TQM and TPM alone on parameters of profitability is again same in stability phase.

Take in Table VII

Profitability Improvement in Maturity Phase

The analysis for improvement in profitability in maturity phase could be carried out only for TQM and Combined approach, due to lack of sufficient data for TPM. The mean values of the three variables for Combined approach are higher than TQM. This indicates that contribution of Combined approach is more than TQM on parameters of profitability.

The two tailed t tests with 5% significance level are carried out to determine the significance of difference on improvement in F1, F2 and F3. The t values obtained are - 1.30 (p=0.21), - 0.40 (p=0.71) and - 0.70 (p=0.48) respectively. The results show that the differences between means are not significant at 5% confidence level. The results of t tests are given in table VIII.

Take in Table VIII

The results imply that hypothesis H1b for improvement in F1, F2 and F3 is not true for maturity phase, though mean values for combined approach are higher for all the three parameters. However, more reliable results could have been obtained with larger sample sizes, but due to limited number of companies adopting Combined approach, this was not

possible even after exhausting almost all sources. The mean values, otherwise, provide an indication of Combined approach being more effective even in maturity phase, but it could not be established statistically due to lack of sufficient data.

Improvement in Operating Performance through TQM and TPM

The analysis for operating performance parameters is carried out on similar lines as in case of profitability. The two tailed t test and single factor ANOVA techniques are used for this purpose. The mean and standard deviation calculated for each of the parameter of operating performance are given in table IX

Take in Table IX

Improvement in Parameters of Operating Performance in Transition Phase

In transition phase (less than 3 years of experience), the mean values obtained for TPM are more than TQM on parameters of productivity (2.55 & 2.33) and safety (3.05 & 2.63), whereas on quality, delivery, cost and employee morale, the mean values of TQM are more than TPM. This indicates that the effect of TPM has been more in improving productivity, production capacity as well as safety and hygiene of the organizations, whereas TQM has greater effect on quality, delivery and cost in transition phase. The two tailed t tests with 5% significance level are carried out to understand the significance of difference on mean values for TPM and TQM. The values obtained are t=0.73 (p=0.47) for productivity; t= - 0.10 (p=0.44) for quality; t = - 0.50 (p=0.63) for cost; t= - 0.51, p= 0.60 for delivery; t= 0.87 (p=0.39) for safety & hygiene and t= 0.16 (p=0.87) for employee morale. Results are given in table X.

Take in Table X

The t values for two tailed test and at 5% confidence level imply that the differences in mean values are not significant. Therefore, the hypothesis H2a is proved for all the parameters of operating performances in transition phase. This validates the proposition that TQM and TPM have equal impact on operating performance parameters.

Improvement in Operating Performance in Stability Phase

In order to determine the significance of difference for improvement in performance parameters by the three approaches adopted [i.e. TQM, TPM and Combined in stability phase, single factor ANOVA test at p=0.05 was conducted on all six parameters. The results of ANOVA are shown in the table XI

Take in Table XI

The F values for productivity, quality, cost and delivery parameters are found to be higher than critical F value at p=0.05. Therefore, it can be concluded that there is significant difference in improvement in these parameters contributed by three approaches. Individual t tests establish that mean values for combined approach on these parameters are significantly higher than TQM and TPM alone, but there is no significant difference in values for TQM and TPM. However, F values for other parameters are less than critical F value, though mean values for combined approach are higher than TQM and TPM.

The hypothesis H2a is proved to be true that TQM and TPM have equal contribution in improving parameters of operating performance. Hypothesis H2b is also true for productivity, quality, cost and delivery parameters. The hypothesis H2b, however, could not be proved for safety &hygiene and employee morale.

Improvement in Operating Performance in Maturity Phase

The comparative assessment of effectiveness of TQM and Combined approach for maturity phase is carried out with the help of two tailed t test on data for six parameters of operating performance. The TPM approach could not be included due to lack of sufficient data. The t values obtained between TQM and Combined approach are - 2.40 (p=0.04), - 3.00(p=0.04), - 2.50(p=0.03), - 2.71(p=0.047), - 1.40 (p=0.17) and 0.22 (p=0.83) respectively for P,Q,C,D,S and M. This implies that the differences between TQM and Combined approach are proved to be significant for productivity, quality, cost and delivery parameters. Therefore, null hypothesis H2b is proved to be true for productivity, quality, cost and delivery parameters in maturity phase. The hypothesis H2b again could not be proved for safety &hygiene and employee morale. The results of t tests are given in table XII. The TPM approach could not be considered for statistical analysis due to lack of sufficient data.

Take in Table XII

Interpretation and Conclusion

The effectiveness of Japanese Quality and Maintenance solutions in improving business performance of Indian manufacturing industry, both in terms of profitability and operational parameters is established in this paper. The effectiveness of these

improvement solutions is established both in case when these are used individually as well as simultaneously. The analysis was carried out for three phases of implementation i.e. transition, stability and maturity phase. The mean values for parameters of profitability and operating performance show obvious signs of improvement right from the beginning of implementation, though it has been very marginal in transition phase. The findings in case of transition phase are justified because both TQM and TPM require initial investments to be incurred for their implementation in terms of employee training, documentation, mobilization and investment in infrastructure etc. The marginal performance improvement may be due to initial orientation resistance of employees and middle level executives, previous history of quality and productivity improvement exercises, lack of availability of data and its formatting, unionism etc. This demands interaction with other departments. Understanding process requirement takes time as people are mostly conditioned to work with function centric methodologies. Though, the period required to stabilize the implementation of these drives varies from company to company due to factors like nature and extent of activities, size of organization and its heterogeneity, education and maturity level of employees, but normally this period is of approximately three years.

The improvement in stability and maturity phase has been considerable to justify the effectiveness of both TQM and TPM in improving business performance of Indian manufacturers. The comparative assessment of effectiveness of TQM and TPM indicates that both are equally effective in bringing improvements. This may for the reason that both TQM and TPM attack on inefficiencies, non- value adding activities, various types of wastes and defects. Both work on the philosophy of continuous improvement and cover the entire gamut of business involving tall employees from top to bottom with different

focus. The former concentrates on quality and later one focuses on equipment or physical assets. But, both cover all management and control activities of the business. The higher effects of combined approach could not be proved for safety and hygiene and employee morale. This may be due to the fact that these aspects are sufficiently addressed in both TQM and TPM and there is not much difference in the way these issues are viewed under TQM and TPM.

Based on the analysis and interpretation of the data this may be concluded that achieving successful implementation of Japanese techniques and practices is not an issue for Indian manufacturing. The challenge of Indianization of these practices is, however, how to harbor such practices for the long-term growth and benefit of the organizations on the whole. The study, therefore, recommends that organizations intending to go for any Japanese practice should first understand the need to use that Japanese solution /practice and its application, prepare for its adaptation, and then identify the ways and measures required for its successful implementation.

The study establishes the potential of both TQM and TPM to steer the movement of competitiveness in Indian manufacturing industry. The complementary nature of TQM and TPM and their synergetic effect, when implemented in tandem is also ascertained in Indian context. The study clearly reveals the extent to which the willing acceptance of Japanese Quality and Maintenance solutions has resulted in the emergence of an organizational culture that has raised the level of technical skills ,quality control , managerial synchronization and the employee involvement to the levels hitherto unseen in Indian industry. The study also reveals that both drives aim for long term improvement in

performance and, therefore, practitioners should not judge the effectiveness of these drives just by looking at short term performance.

Appendix A

Scale: (1- No improvement 2- very little improvement(< 5%) 3- considerable improvement (5to 20%) 4- Large improvement (21 to 100 %) and 5- Very large improvement (> 100 %)

Measures of Profitability:

1. Increase in customer base in terms of market share.	1	2	3	4	5
2. Increase in profitability in terms of return on investment (ROI).	1	2	3	4	5
3. Increase in profitability in terms of net profit	1	2	3	4	5

Measures of Operating Performance

Productivity					
1. Improvement in labour productivity	1	2	3	4	5
2. Improvement in value added per employee	1	2	3	4	5
3. Improvement in production capacity	1	2	3	4	5
Quality					
4 Reduction in defects during process	1	2	3	4	5
5. Reduction in defects in final product	1	2	3	4	5
6. Reduction in claims from customer	1	2	3	4	5
Cost					
7. Reduction in cost of production	1	2	3	4	5
8. Reduction in cost of manpower	1	2	3	4	5
9. Reduction in total cost of supply chain (supplier to customer)	1	2	3	4	5
Delivery					
10. Reduction in total cycle time (from order to delivery)	1	2	3	4	5
11. Improvement in inventory turnover (reduction in Inventory)	1	2	3	4	5
12. Improvement in meeting delivery schedules in time	1	2	3	4	5
Safety & Hygiene					
13. Reduction in accidents and safety failures	1	2	3	4	5
14. Improvement in level of pollution and hygiene conditions	1	2	3	4	5

Employee Morale	
15. Improvement in Improvement ideas and employee suggestions	1 2 3 4 5
16. Increase in small group meetings and employee involvement	1 2 3 4 5

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How has Japanese management evolved? It might seem far-fetched to argue that Japan's postwar growth has anything to do with management theory. After all, the average salaryman, relaxing at the end of a 10-hour day with Yakitori and sake, hardly spends his time talking about Drucker-san and Peters-san.Â Indeed, you had a quality department to take care of that very thing. Even today, Japanese managers speak of Joseph Juran, A.V. Feigenbaum and, particularly, W. Edwards Deming in the same hushed tones that people normally reserve for a deity.Â Anybody who considers writing off Japanese management, however, should remember two things. First, that the country remains the world's leading center of manufacturing excellence. Quality management is the act of overseeing different activities and tasks within an organizationCorporate StructureCorporate structure refers to the organization of different departments or business units within a company. Depending on a companyâ€™s goals and the industry to ensure that products and services offered, as well as the means used to provide them, are consistent. It helps to achieve and maintain a desired level of quality within the organization. Quality management consists of four key components, which include the following: Quality Planning â€“ The process of identifying the quality standards relevant to the project and deciding how to meet them. ... Qualityze quality management software for manufacturing industry enables you to comply with GMP standards such as ISO 9001 and US FDA. The Qualityze enterprise quality management software solution for manufacturing companies is a closed-loop quality system which includes Document Management, Change Management, Nonconformance Management, CAPA Management, Audit Management, Training Management, Complaints Management, Supplier Quality Management, Calibration Management, Maintenance Management with exciting features like Audit Trail, Electronic Signature, Social Collaboration, Dashboards, Reports, ...Â Controlling and managing quality through a complete assessment of a product tends to Operations management is the management of processes that transform inputs into goods and services that add value for the customer. Learning Objectives. Explain the role of operations management. Key Takeaways. Key Points. The goal of operations management is to maximize efficiency while producing goods and services that effectively fulfill customer needs. Operations is one of the three strategic functions of any organization.Â Controlling the transformation process makes it difficult for competitors to manufacture products of the same quality as the original producer. Key Terms. output: Production; quantity produced, created, or completed. In his book "Japanese Manufacturing Techniques: Nine Hidden Lessons in Simplicity", Richard Schonberger presented nine "lessons" the world could learn from the Japanese.Â Another area in which Japanese management has successfully tapped into worker potential is in the use of small group improvement activities (SGIA). One example is quality circles, a small group of volunteer employees who meet once a week, on a scheduled basis, to discuss their functions and the problems they are encountering.Â Jidoka is a quality concept that means "stop everything" whenever an error occurs. It is controlling quality at the source.Â While not all major Japanese businesses are keiretsu, most of Japan's major corporate entities are.